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ABSTRACT

In the present study, storage and retrieval organization were contrasted in 50 elderly and 50 young adults. It was expected that the older subjects would recall less material than younger adults as a result of poorer organization in long-term memory storage. The learning material consisted of 25 related fictional "historical" sentences which could be organized into three conceptual types, five countries, five decades, and five topics. The results of the study indicated apparent age differences in storage ability and large differences in retrieval cue retention and recall; however, it was not possible for the authors to distinguish clearly between storage and retrieval processes, a distinction difficult to make on the theoretical level as well. They summarized that the elderly, who stored less material, could not be expected to recall associations between cues and events on sentences that were not formed in storage. (Author/PC)

ADULT AGE DIFFERENCES IN STORAGE AND
RETRIEVAL PROCESSES IN THE RETENTION
OF RELATED SENTENCES

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Cross-sectional research on memory functioning in adults has suggested that elderly persons do not organize new information as efficiently as do younger adults. Other research has been concerned with distinguishing between storage and retrieval processes in memory as possible areas of impairment in old age. In the present study, storage and retrieval organization were contrasted in elderly and young adults. It was expected that the older subjects would recall less material than younger adults as a result of poorer organization in long-term storage.

Fifty elderly and fifty young adults served as subjects. The average ages of the 2 groups were 72 and 21 years. There were equal numbers of males and females. All subjects attending college at the time, and all were unpaid volunteers.

The learning material consisted of 25 related fictional "historical" sentences similar in style to those used by Sasson (1971). Five of these are shown in Table 1.

Insert Table 1 about here

As you can see, each sentence describes an event and contains one country and one date. Altogether, there were 5 countries and 5 decades, and the events could be grouped into 5 topics (ecology, synthetic textiles, medicine, space exploration, and education in underdeveloped countries). Thus, the sentences could be organized into 3 basic conceptual types: topics, countries, or decades. Chronological ordering within types was also possible and was considered to represent a higher degree of organization than by type alone.

Subjects were given all 25 sentences on separate cards in an unsystematic order and were instructed to form their own groupings based upon whatever system seemed logical to them. This procedure was based upon the free-sorting technique devised by Basden and Higgins (1972) as a modification of Mandler's (1967) sorting task. Mandler's sorting procedure with words had been used with elderly subjects by Hultsch (1971), who found that the older group sorted as well as the younger group but recalled fewer words. While Hultsch concluded that there were no age differences in storage organization, it is also possible that the elderly had in fact sorted the words less efficiently than the younger adults. However, the measures of sorting performance did not directly assess the content of the groups formed by each subject. If the elderly had a less efficient conceptual basis for sorting than the younger group, this would not have been detected with Hultsch's measures. In the present study sentences that could be grouped in alternate ways were used to provide a more direct means of observing age differences in actual category content.

After sorting all sentences, the subject was allowed to read over the sentences within the groups, and then wrote free recall. The sorting and recall procedure was then repeated once more. Following a short rest period, the subject was given an immediate recognition memory test for 5 additional sentences similar in form and content to the original 25. For each sentence, there were 4 questions which measured recognition of the country, date, topic and main event. This test was used to measure original

acquisition of the information contained in each sentence when the decay in storage was assumed to be minimal.

Organization during sorting and recall was assessed according to: (1) clustering scores for major conceptual type, and (2) the extent of chronological subgrouping, or hierarchical organization. The clustering measure for conceptual type was based upon Frase's (1969) method of assigning several separate scores to each group of sentences according to the number of repetitions of sentences related by topic, country, and decade. Each subject was classified as using the type of organization for which he received the highest score. Then, subgrouping within type was assessed by counting the numbers of sentences that occurred in exact chronological order within each conceptual type.

Two additional measures of organization were derived from recall. These assessed the formation and retention of associations between the main event and one of two potential cues in the sentence: the country and the date.

The data was analyzed in two stages. First, factor analyses for the 2 trials assessed the relationships among age, the organizational variables, time taken for the sorting task, and recognition test performance. Factor scores were then obtained for each subject and used as independent variables in separate step-wise multiple linear regressions for each trial. Scores on event recall for each trial were the dependent variables.

Six principal components factors were extracted and rotated for each trial. The six factors accounted for 61% of the variance on Trial 1 and 70% on Trial 2.

Insert Table ? about here

The major results from the factor analysis are as follows: On both trials, the pattern of factor loadings suggested that the elderly had lower recognition test scores than the young adults and spent more time sorting the sentences. On the second trial, it appeared that the older subjects retained fewer retrieval cues than did the younger group, as age and Retrieval Cue Retention had inverse loadings on Factor VI. On Trial 1 and Trial 2, topic and country organization loaded on the same factor. On Trial 1, there were 2 separate Factors for sorting organization and Recall Organization, and on Trial 2 these measures loaded highly on the same Factor (III).

These results indicated that age was not related to either type or hierarchical degree of organization for sorting of the sentences. Other results suggested age differences in storage organization which were not observed with the sorting task.

The elderly apparently did not organize the material within each sentence by associating retrieval cues with events, as evidenced by their relatively low scores on all questions of the recognition test. This failure to initially form associations among parts of the sentences would then have contributed to a poorer retention of retrieval cues. In contrast, the failure to find any relationships between age and type or amount of suborganization suggests that the elderly and young adults were equally able to retain and then retrieve their overall sentence organization.

Evidence for age differences in storage organization was also provided by the finding that the elderly required more time than the young adults to sort the sentences on both trials. Hulicka and Weiss (1965) also had observed that the elderly required more time for acquisition, and the present study suggests that at least some of this time may have been spent organizing the information into long-term storage.

The results of the multiple regression analysts are shown in Table 3. There were large age differences in event recall, as indicated by the significant of the contribution of the age

Insert Table 3 about here

factor, in addition to large age differences in mean scores on event recall (22 vs. 48 on Trial 1, 36 vs. 76 on Trial 2 for elderly and young adults, respectively). Moreover, the amount of event recall was found to be strongly related to retrieval cue retention, to the use of subgroupings on Trial 1, and sorting and recall organization on Trial 2. Thus, the elderly's relative deficiency in the use of retrieval cues seems to have been strongly related to their poorer recall.

In contrasting the results of the present study with those of Hultsch (1971) regarding age differences in storage organization, it seems that the use of sentence material resulted in a more sensitive measure of age differences in acquisition than did the use of unrelated words. In both studies, aged and young adult Ss achieved similar sorting groups. However, the two age groups did not actually learn the material contained within the

categories in the same way, as the present experiment suggested. The more subtle differences in acquisition of material contained within each sentence were not detectable with Hultsch's methodology.

Although the present results have indicated apparent age differences in storage ability and large differences in retrieval cue retention and recall, it has not been possible to make a clear distinction between storage and retrieval processes. At the operational level, it was necessary to use measures derived from recall performance to infer differences in storage of the sentences. The sorting procedure alone was not sufficiently sensitive to examine the acquisition process.

The distinction between storage and retrieval processes has also been difficult to make theoretically. Research differentiating between the two has involved similar problems in that memory tasks assumed to reflect retrieval processes actually are also dependent upon the way in which the material is acquired. Examples of such tasks include comparisons of recall and recognition performance (McNulty and Caird, 1966; Tulving, 1968), retrieval plans (Bower, Clark, Lesgold and Winzenz, 1969) and retrieval cues (Tulving and Pearlstone, 1966). Mandler (1972) and Tulving and Thomson (1971) have demonstrated that recognition which was thought to depend on decision processes also involves organization and retrieval.

In examining the performance of aged Ss, it must be recognized that if less material is stored, then less can be retrieved. The poorer performance of the elderly on recall may reflect either less efficient retrieval, storage, or both. In the present study

the elderly could not be expected to recall the associations between cues and events with each sentence that were not formed in storage. In future research on memory organization in the aged, it would seem to be of limited value to continue the attempt to distinguish between storage and retrieval processes. Both processes appear to contribute to poorer memory in the aged.

Table 1
Five of the Twenty-Five Sentences
Used as Stimulus Material

The largest rocket ever made was launched in 1969 by the Americans and will tell whether there is life on other planets.

One of the major achievements of England's colonial policy in 1875 was the encouragement of education in the most underdeveloped countries.

The natural environment of Russia was threatened by the harsh winter of 1878 which ravaged the land and almost destroyed many animal species.

In the year 1958 a crisis in Denmark occurred when rural lobbyists tried to persuade the parliament to increase duties on man-made textiles.

An earthquake in Italy in 1904 which destroyed one of its largest cities was followed by a series of infectious diseases which threatened the whole country.

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Table 2

Rotated Factor Matrices for Trials 1 and 2

Variable	Trial 1					
	Factor I	Factor II	Factor III	Factor IV	Factor V	Factor VI
Age	+.011	+.803 ^a	+.116	+.093	-.045	-.269
Sex ^b	+.143	+.074	+.342	+.027	-.294	+.612 ^a
Comprehension Test	+.018	-.697 ^a	+.067	+.100	+.134	+.379
Time Sorting	+.004	+.770 ^a	-.041	+.035	+.184	+.181
Time Reading	+.019	+.308	-.246	+.022	+.347	+.407 ^a
Topic Sorting	+.831 ^a	+.250	-.021	+.246	+.096	-.027
Location Sorting	-.897 ^a	-.082	+.212	+.176	-.025	-.030
Decade Sorting	-.035	-.176	+.151	-.765 ^a	-.139	+.131
Degree 1 Sorting	-.116	+.095	+.812	-.094	+.078	+.120
Degree 2 Sorting	-.052	-.099	+.742 ^a	-.073	+.247	+.027
Topic Recall	+.737 ^a	-.174	+.021	+.418 ^a	+.219	-.119
Country-Recall	-.849 ^a	+.159	-.001	+.158	+.034	+.138
Decade Recall	+.006	+.094	+.025	-.879 ^a	+.043	-.075
Degree 1 Recall	-.007	+.009	+.264	+.198	+.758 ^a	-.107
Degree 2 Recall	+.201	+.010	+.129	-.072	+.810 ^a	+.186
Country Event.	-.219	-.194	+.023	+.052	+.109	+.736 ^a
Date-Event	-.134	-.336	+.063	-.276	+.118	+.663 ^a

^aIndicates factor loadings of greater than .40^bMales = 1, Females = 0

Table 2 (Continued)

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Variable	Trial 2					
	Factor I	Factor II	Factor III	Factor IV	Factor V	Factor VI
Age	-.017	+.692 ^a	-.118	-.189	-.443 ^a	+.067
Sex ^b	+.102	-.028	+.027	+.170	+.089	+.739 ^a
Time Sorting	-.257	+.757 ^a	+.019	-.022	+.111	+.040
Time Reading	-.056	+.075	-.109	-.150	+.638 ^a	-.071
Topic Sorting	-.887 ^a	+.146	-.237	+.008	+.006	+.158
Location Sorting	+.853 ^a	-.254	+.194	-.124	-.019	-.018
Decade Sorting	+.207	+.363	+.175	+.404 ^a	+.043	-.506 ^a
Degree 1 Sorting	+.192	+.100	+.751 ^a	-.031	-.069	+.091
Degree 2 Sorting	+.099	+.043	+.752 ^a	-.069	+.191	-.071
Topic Recall	-.909 ^a	-.069	+.081	+.206	+.004	+.068
Country Recall	+.893 ^a	+.032	-.119	+.197	+.118	-.016
Decade Recall	+.127	+.131	+.030	-.855 ^a	-.052	-.091
Degree 1 Recall	-.072	-.189	+.761 ^a	+.318	-.068	+.005
Degree 2 Recall	-.081	-.153	+.746 ^a	-.067	+.150	+.005
Country-Event	+.141	-.034	+.131	+.059	+.779 ^a	+.040
Date-Event	+.009	-.268	+.161	+.245	+.675 ^a	+.101
Inter-Trial	-.331	+.153	+.057	-.044	-.040	+.663 ^a
Consistency, Sorting						

^aIndicates factor loadings of greater than .40^bMales = 1, Females = 0

Table 3

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Results of Stepwise Multiple Linear Regressions for
Both Trials

Factor	Increment to R^2	F	df	p
Trial 1:				
Retrieval Cue	.	.		
Retention	.2194	27.55	1,98	.001
Age	.1921	31.67	2,97	.001
Degree of Organi-				
zation, Recall	.1399	29.93	3,96	.001
Decade Organization	.0107	4.59	4,95	.005
Trial 2:				
Retrieval Cue				
Retention--Age	.4080	67.54	1,98	.001
Age	.1203	27.74	2,97	.001
Degree of Organization,				
Sorting and Recall	.0725	17.45	3,96	.001
Unrelated Variables	.0194	4.87	4,95	.005
Decade Organization	.0111	2.83	5,94	.025

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